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ABSTRACT

Based on a doctoral dissertation that involved a study of the nation's 100 most successful school computer systems, this report summarizes the study's purpose, scope, methodology, resultant model, general observations, and future implications. The model is divided into two major sections: (1) strategic planning activities, focusing on computer system inputs; and (2) tactical planning activities, discussing computer system processes, outputs, and feedback. Questionnaires were submitted to 75 school districts nominated for their outstanding administrative computer systems and 50 districts nominated for their outstanding instructional computer systems. Responses from 100 (80 percent) of the school districts cited useful concepts and practices. Telephone interviews with 24 survey respondents augmented the questionnaire data. Focused on the design of microcomputer and minicomputer systems, the model guides the design of inhouse computer systems for both administrative and instructional applications. Step-by-step procedures outline the key concepts of the study: that planning is a central element of the computer design process at all stages, and that user involvement should be pervasive through the planning, implementation, and growth of the computer system. (MLF)

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A COMPREHENSIVE MODEL FOR THE DESIGN OF MICRO AND MINI COMPUTER SYSTEMS IN SCHOOL DISTRICTS

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A COMPREHENSIVE MODEL FOR THE DESIGN OF MICRO AND MINI COMPUTER SYSTEMS IN SCHOOL DISTRICTS

This research presentation is based upon a doctoral dissertation completed at the State University of New York at Buffalo, which involved a detailed and comprehensive study of the nation's 100 most successful school computer systems. A book based on this study is being published by the Research and Development Division of the New York State Association of School Business Officials and is scheduled for release in August 1986. The following remarks summarize six parts of the study: its purpose, its scope, the methodology used, the resultant model, general observations and future implications.

PURPOSE OF THE STUDY

Computers have become pervasive in our society, creating opportunities to accomplish old tasks in new, more efficient ways. This has led to increased pressure to emplace computer systems in school districts. Educators are attempting to meet the management and instructional computing needs in their districts by designing computer systems; however, the results of their efforts have met with varied degrees of success. Educational administrators have discovered that designing in-house computer systems can be very difficult, and unfortunately, there appeared to be no macroscopic model readily available to help them with this task. Therefore, the purpose of this study was to create a comprehensive model containing concepts and practices that can be used to guide the planning and implementation of micro or mini computer systems in school districts. The model is a step-by-step guide to computer system design and can be used by those with little or no computing background.

SCOPE OF THE STUDY

The study focused on the design of micro and mini computer systems, rather than mainframe computer systems. Also, this research was limited to in-house computer systems, as opposed to services purchased from educational computing consortia. The study's model can be used to guide the design of computer systems for both administrative and instructional applications because its scope is not limited to specific data processing applications or selected aspects of computer system design. Because the study is grounded in general systems theory, the study's end-product is a model that is comprehensive in nature: It considers all phases of the design process and all systems within a school district that may be affected by a new or improved computer system. Furthermore, the methodology used in this research makes the results generalizable, and therefore useful, to a wide variety of school districts.

RESEARCH METHODOLOGY

The research methodology had five phases: (1) a review of the relevant literature; (2) field research; (3) data analysis; (4) model development; and (5) model evaluation.

Review of the Relevant Literature

The purpose of the literature review was to gather information on all topics which could be included in a macroscopic model for computer system design. Because there were no holistic models of this nature in the literature, a wide search was necessary. Investigated were change theory, computer system design, education, electronic technology, ergonomics, general systems theory, management information systems, networking and telecommunications, and planning. The result was a preliminary set of design criteria that provided a skeleton and a starting point for the study's model. Systems theory in

general and the input-process-output (IPO) model in particular provided a suitable framework for organizing the design criteria. An IPO model was used because it is an uncomplicated and universally applicable model that can simplify the study of a system with an extensive number of interrelated parts, such as a computer system. Furthermore, presenting concepts and practices in the logical order of inputs, followed by processes, outputs, and feedback, corresponded to the sequential order of computer system design activities recommended in the literature. This preliminary set of design criteria was then refined by the results of the field research.

Field Research

The field research consisted of a survey of selected school districts and telephone interviews with computer system designers/managers of districts chosen from the survey populations. The purpose of the field research was to determine which concepts and practices contained in the preliminary set of design criteria were actually being used by practitioners to design in-house computer systems.

Nomination Process

For this study, it was important to include only those school districts that had designed efficient and effective computer systems; it would not have furthered model development to include input from those school districts that had done a poor job of designing their computer systems. Therefore, a nomination process was used to gather a pool of appropriate school districts.

Nominators from across the nation were asked to submit names of school districts considered outstanding in the design or use of their computer systems as per a set of nominating criteria. The nominator population consisted of the researcher's dissertation committee, the study's panel of experts (a

group of eight individuals in New York State who were knowledgeable about education and computers), individuals suggested by the dissertation committee and the panel of experts, state presidents of the Association of Educational Data Systems (AEDS), selected state presidents and executive directors of the Association of School Business Officials (ASBO), and names culled from the literature. Seventy-two nominators from twenty-six states across the nation responded to the request for names of school districts; this was 60.5% of those contacted. This resulted in 75 school districts nominated for their outstanding administrative computer systems (the administrative population for the survey) and 50 school districts nominated for their outstanding instructional computer systems (the instructional population for the survey).

Survey Process

A survey was then used to help refine the preliminary set of design criteria. The nominated school districts were sent questionnaires to determine which design concepts and practices they had found useful. One hundred school districts across the nation -- 80% of those contacted -- responded to the survey. All geographic areas of the country were represented.

The content of the questionnaire was based upon the preliminary set of design criteria extracted from the literature. The survey instrument contained three kinds of questions:

1. **Positively-worded statements with yes/no responses** (close-ended). Respondents were presented with a concept or practice whose use during computer system design was recommended by the literature. Respondents indicated "yes" for use or "no" for non-use of that item. The majority of questions were of this nature;

2. **Mutually exclusive check list questions** (close-ended). Respondents were presented with a number of mutually exclusive options and then were instructed to choose one;

3. **Open-ended questions**. Respondents were presented with a question to which a written, narrative reply was appropriate.

All close-ended questions contained two scales. All but two questions had an "actual" and a "hindsight" scale. Using the "actual" scale, respondents answered the questions as they pertained to the process of computer design as it actually occurred in their school districts. With the "hindsight" scale, respondents drew upon their design experiences to answer the questions as they pertained to the process of computer system design if it were to be done over in their districts. For two questions, use of a "present" and a "future" scale was more logical.

The purpose of having two scales was to aid model development. The degree of congruence between responses on the two scales gave a clearer picture of respondents' endorsement of that concept or practice as opposed to using only one scale.

The questionnaire contained four sections:

1. **General concepts and practices.** These questions dealt with the following design issues: planning, development of specifications, standardization of materials, user training, user support, systematic implementation, system security, centralization of functions, and evaluation and planned change;

2. **Specific computer system design practices.** This section sought information on the electronic arrangement of the hardware in the computer system and on who performs equipment maintenance and repair for the computer system;

3. **Situation-specific questions.** These were optional questions for survey respondents, to be answered only if the topics were applicable to the design of their computer systems. The questions focused on planning committee membership, service contracts, and use of parallel runs;

4. **Open-ended questions.** This section contained four open-ended questions whose topics were: (1) steps taken by the district to foster user acceptance of the computer system; (2) significant anticipated changes to the present computer system; (3) types of written documents that exist to guide users of the computer system; and (4) key advice to those who will design computer systems.

Interview Process

Twenty-four survey respondents were interviewed by telephone. The purpose of these interviews was three-fold: (1) to augment knowledge of promising concepts and practices identified in the literature and the survey; (2) to obtain clarification of issues not resolved by survey results; and (3) to enrich model development by obtaining from computer system designers recommendations that were more insightful than those that could be given on a questionnaire.

Data Analysis: The Data Analysis Paradigm

The Data Analysis Paradigm was the first step in building a comprehensive model for the design of computer systems in school districts. The results of these analyses were used in the Model Development Paradigm to help construct the study's model. The Data Analysis Paradigm consisted of two parts: determining data merger and forming data patterns.

Part 1: Determining Data Merger

The purpose of Part 1 was to determine for which survey questions administrative population data and instructional population data could be merged and for which questions data from the two populations should remain segregated. This had implications for both the next part of data analysis and for model development. Responses from the administrative population were compared with responses from the instructional population, controlling for scale. Thus, for data from each survey question, two comparisons were made:

1. "Actual" scale: Administrative population responses vs. instructional population responses;
2. "Hindsight" scale: Administrative population responses vs. instructional population responses.

If, for both scales, no statistical significance was found, responses from the two populations were merged for that question because respondents' answers were independent of their population; there was no association between a respondent's population and his or her answer to the question. If statistical significance existed for the population comparisons in either the "actual" or the "hindsight" scale, data from the two populations were not merged for that question. A chi-square test was used to determine the presence or absence of statistical significance, and an alpha level of 0.01 was used to avoid Type I errors.

Part 2: Forming Data Patterns

The second Part of the Data Analysis Paradigm was to determine if, for each survey question, there was a difference between what respondents actually did during the design process ("actual" scale) and what they would have done if they were to repeat their design experiences ("hindsight" scale) -- and the nature of that difference. This was done for each question by forming data patterns from the responses on both scales. These data patterns became the basis of the Model Development Paradigm.

The scale comparisons took one of two forms, depending on whether data from the two populations were merged or segregated:

1. **If no statistical significance was found between population responses,** "actual" scale responses were compared with "hindsight" scale responses for all respondents (that is, responses from the administrative population merged with responses from the instructional population);

...or...

2. **If statistical significance was found between population responses:**

   a. "Actual" scale responses were compared with "hindsight" scale responses for the administrative population alone;

...and...

b. "Actual" scale responses were compared with "hindsight" scale responses for the instructional population alone.

Because each close-ended question had two scales, the range of possible responses could be depicted in matrix form, with the number of cells determined by the number of possible response choices for each scale. To form data patterns, frequencies and percentages of response frequencies were calculated for each cell of the matrix of each question as follows:

1. **For each positively worded statement with a yes/no response choice,** data were analyzed in a 2 x 2 matrix format;

2. **For each mutually exclusive check list question,** data were analyzed in an N x N matrix format, with the number of response choices determining the value of N.

The two survey questions with "present" and "future" scales were treated the same as questions with "actual" and "hindsight" scales.

Model Development: The Model Development Paradigm

There were two ways in which the Model Development Paradigm used the results of data analysis to develop the study's model:

1. **Generalization of findings.** To indicate which survey and interview findings were applicable to school district computer systems in general and which findings were applicable to only administrative computer systems or instructional computer systems;

2. **Refinement of the preliminary set of design criteria.** To indicate which concepts and practices in the preliminary set of design criteria should be retained in the study's model, which should be eliminated, and which should undergo further investigation.

The following is an elaboration of these two model development concepts.

Part 1: Generalization of Findings

The first part of the Data Analysis Paradigm was to compare, for each survey question, administration population responses to instructional population responses. The results of this analysis were used in the Model Development Paradigm to determine whether concepts and practices were generally

applicable or pertained to a particular type of computer system. For questions where no statistically significant difference was found between the two populations, the corresponding concept or practice was discussed in terms of its applicability to all types of computer systems, regardless of function. Where data analysis revealed a statistically significant difference between responses from the two populations, discussion was separated into relevance of the concept or practice for administrative computer systems or for instructional computer systems. This particular facet of the Model Development Paradigm helped make the study's model both universal in nature and system-specific, thereby increasing its potential utility.

Part 2: Refinement of the Preliminary Set of Design Criteria

One purpose of the field investigations was to use the experience of practitioners, i.e., survey respondents, to refine the preliminary set of design criteria. Questionnaire items were based upon concepts and practices suitable for inclusion in the process of computer system design as suggested by the literature. Where practitioners recommended the use of a particular concept or practice, thus agreeing with the literature, that concept or practice was retained in the study's model. There were some instances, however, where the practitioners did not recommend use of a concept or practice and did not agree with the literature; those concepts and practices were eliminated from the comprehensive model. The researcher relied more heavily on practitioners' viewpoints, because data from surveys and interviews were the result of actual hands-on experience with computer system design, rather than speculation or theory, which may or may not have been field-tested.

The second part of the Model Development Paradigm is based upon the assumption that each item has two scales, "actual" and "hindsight" and two mutually exclusive responses. The second task of the Data Analysis Paradigm

was to compare, for each survey question, "actual" scale responses to "hindsight" scale responses. The results of this data analysis yielded percentages of responses in each of four quadrants as depicted in the Quadrant Matrix, Figure 1 below.

"ACTUAL" SCALE	"HINDSIGHT" SCALE: yes	"HINDSIGHT" SCALE: no
yes	**QUADRANT I** "Actual:" Yes "Hindsight:" Yes	**QUADRANT II** "Actual:" Yes "Hindsight:" No
no	**QUADRANT IV** "Actual:" No "Hindsight:" Yes	**QUADRANT III** "Actual:" No "Hindsight:" No

Figure 1. Quadrant Matrix

For each question, the distribution of frequencies in the quadrants resulted in one of five data patterns:

1. **Single quadrant data pattern.** The majority of response frequencies were in one quadrant, either Quadrant I, Quadrant II, Quadrant III, or Quadrant IV;

2. **Diagonal data pattern.** The majority of response frequencies were in two diagonal quadrants, either Quadrants I and III or Quadrants II and IV;

3. **Column data pattern.** The majority of response frequencies were in two quadrants in the same column, either Quadrants I and IV or Quadrants II and III;

4. **Row data pattern.** The majority of response frequencies were in two quadrants in the same row, either Quadrants I and II or Quadrants II and IV;

5. **No discernible pattern.**

The Model Development Paradigm consisted of a set of decision rules based on the above data patterns and the distribution of frequencies within those patterns. These decision rules helped determine the degree of endorsement by survey respondents of each concept or practice. Based on the decision rules contained in the Model Development Paradigm, each concept or practice tested in the questionnaire was incorporated into the study's model in one of five ways:

1. **Included in the study's model as necessary** for the successful design of school district computer systems (strongly endorsed by the survey populations);

2. **Included in the study's model as desirable, but not necessary,** for the successful design of school district computer systems (weakly endorsed by the survey populations);

3. **Included in the study's model as optional** for the successful design of school district computer systems (judged by the survey populations to be a non-critical issue);

4. **Noted in the study's model as unnecessary or undesirable under ideal conditions** for the successful design of school district computer systems (weakly rejected by the survey populations);

5. **Excluded from the study's model and/or noted as counterproductive** to the successful design of school district computer systems (strongly rejected by the survey populations).

The Model Development Paradigm was applied to close-ended survey questions with two scales, whose data could be placed in the two-by-two quadrant matrix. The Paradigm was altered slightly for mutually exclusive check list questions with N x N matrices. Part 1 of the Paradigm, Generalization of Findings, was applied to data from these questions to determine if they should be merged or segregated by population. For Part 2 of the Paradigm, Refinement of the Preliminary Criteria, cell percentages resulting from a comparison of

"actual" and "hindsight" (or "present " and "future" scales) were interpreted without the benefit of a quadrant matrix and discussed in the study's model. The decision to retain or eliminate a concept or practice from the study's comprehensive model was guided by recommendations of practitioners.

Use of Data from Open-ended Survey Questions and Telephone Interviews

The Data Analysis Paradigm and the Model Development Paradigm were not used on these data because of their subjective and unstructured nature. A unit record approach was employed to standardize answers as much as possible and to classify responses by category and population. Frequencies and percentages were calculated. The information gained from this analysis was used to refine the results of model development by adding new concepts and practices not contained in the preliminary set of design criteria, adding substance and detail with illustrative techniques, and providing clarification by resolving discrepancies that arose during model development.

Model Evaluation

Draft versions of the model were critiqued by the dissertation committee and the panel or experts, who evaluated the model to determine if it was complete, realistic, understandable, flexible, and useful. Evaluation results indicated that the model satisfactorily met all of the model criteria set forth and that it has potential utility for application in school districts.

THE COMPUTER SYSTEM DESIGN MODEL

The study's model is an action guide containing concepts and practices cited in the literature and confirmed by the research populations as necessary or useful for the successful design of school district computer systems. Practices are often illustrated by specific techniques and forms and exhibits submitted by survey respondents. The specific nature of the model could have

taken many forms; however, an input-process-output model was chosen because it provided a framework for organizing the various ideas presented in the model into a logical order and a preferred action sequence. The model is divided into two major sections: (1) strategic planning activities, focusing on computer system inputs; and (2) tactical planning activities, discussing computer system processes, outputs, and feedback. A summary of the model follows.

Part I: Strategic Planning Activities

1. Plan for the Computer System: Choose Purposes and Parts

To guide the entire design process, strategic plans should be developed first. These plans should use a system's approach and be macroscopic in nature. Next, a feasibility study should be conducted to identify the computing needs of the school district and to propose ways to meet these needs. A planning committee should be established, representative of the potential users of a computer system. This committee can then undertake preliminary planning activities, such as committee and meeting organization, securing top management support, providing training of committee members, and writing assumptions and philosophies to direct their future planning efforts. The committee should then assess data needs. This can be done through written surveys of and/or interviews with potential users, examination of existing systems and documents, and discussion by committee members. Based on these needs -- and the assumptions and philosophies determined earlier -- goals and objectives for a computer system can be developed. These will guide specification of required attributes for the selection of material inputs to the computer system, i.e., software, hardware, peripherals, and supplies. The selection criteria should be future-oriented to allow for the growth of the system. Before writing the specifications, however, it is necessary to first

determine the desired electronic configuration for the computer system: stand-alone units, local area network, distributed data processing, or remote area data processing. The degree of standardization of the material inputs should also be established. Only then can specific selection criteria be developed for software, then for hardware and peripherals, and finally for vendors. The committee should next investigate offerings in the marketplace. This can be done through requests for proposals, reference checks, product observation, and trial use. Selections can be made of first software, and then hardware, peripherals, and last vendors. Once selection of material inputs has been made, a computer system budget can be developed, including both investment and recurring costs. It is also appropriate at this time for the committee to investigate sources of funds to finance acquisition of a computer system.

The feasibility study is completed when the planning committee presents its findings to the superintendent, and if appropriate, to the board of education. The committee's report typically makes one of three recommendations: (1) termination of the project; (2) further investigation and study; or (3) acquisition and implementation of a computer system. If the planning committee recommends the last option, and the superintendent and the board approve, the committee can proceed with tactical planning activities.

Part II: Tactical Planning Activities

1. Design a Logical Structure for the Computer System: Establish Organization

The first step in achieving a logical structure for the computer system is to create a comprehensive and integrated system by identifying and then ordering into subsystems all possible components or functions of the computer system. Then, it is necessary to internally integrate those subsystems within

the computer system so that they work in harmony with each other. It is also important to externally integrate the computer system with other departments of the school district to maximize the benefits of the computer system to the district and to minimize disruptions to daily activities.

Next, support and management functions should be centralized; these can include equipment maintenance and repair, purchasing, user training and support, and management and overall system coordination. The latter can be accomplished by designating a computer system coordinator who can facilitate computer system organization, implementation, and operation.

Facilities to house the computer system should then be selected and prepared. In doing this, it is important to pay attention not only to the operating requirements of the computer equipment, but also to the ergonomic (human comfort) needs of the users. It is also appropriate at this time to provide for a system of user support to aid users and to help solve their computing problems. This can be accomplished through a variety of means, including in-house peer support groups, regional user groups, regular school district computing newsletter, and vendor support.

2. Design Effective Processes for the Computer System: Determine Outputs and Deal with Constraints

The first step in achieving effectiveness is to determine the nature and appearance of computer system outputs. These outputs should be designed to meet the computing needs of the district and to reflect the goals and objectives established earlier in the planning process. Following output design, the nature and appearance of data inputs can be developed that will produce the desired outputs.

It is also necessary at this stage to determine possible constraints to computer system effectiveness and to move to obviate them. These constraints

can include: physical and electronic security of the system; software piracy; data inputs that are relevant, timely, accurate, and reliable; and equal access to computers for users, especially in terms of sex equity for student users of instructional computer systems.

3. Design Efficient Processes for the Computer System: Implement the Computer System

An implementation plan for the computer system should be developed which includes a timetable for implementation activities and provides for initial orientation sessions to introduce the new computer system to users and to the school district community. To promote efficiency, user manuals and user training should be provided prior to computer system implementation. The user manuals should include not only technical documentation for operating hardware, software, and peripherals but also procedural documentation to aid users in performing daily operations. This latter type of documentation can include organization charts, job descriptions, statements of goals and objectives, calendars, training materials, written procedures, forms, lists of available software, and reference materials. User training should also be conducted. It is helpful prior to training to write plans outlining the intended audience for training, the purposes of training, the information to be taught, the times and locations of training, and the methods of instruction.

After the above procedures have been accomplished, the computer system can be operationalized. The computer system should be phased in gradually, computerizing one application at a time. Parallel runs of computerized applications should be conducted simultaneously with manual operations. Manual operations should be abandoned only after computerized applications are working satisfactorily.

4. Evaluate the Computer System: Provide for Feedback and Adaptation

Regular evaluation of the computer system is important to determine changes in its environment (the school district or the larger technical, political, or social environments) and to discover the presence of system stress or disorder. The efficiency of computer system operations can be examined though process evaluations using on-going logs of user problems, on-site observations, comparison of the computer system against other school districts' computer systems, and user surveys. The effectiveness of computer system outputs can be determined through product evaluations, such as examination of computer system outputs, measurement of student achievement, measurement of growth in student enrollment in computer classes, on-site visits to other school districts to compare computer system outputs, and questionnaires.

Evaluation results may indicate the need for minor adjustments to the computer system to prevent more serious problems. Some examples include equipment maintenance and repair, expanded use of an application, modification of documents in the user manual, and an update of the computing curriculum. However, evaluation results may also point to major changes to be made to the computer system to combat conditions of system stress and disorder. These can include upgrading existing hardware and/or adding new machines, increasing network capabilities, expanding applications and upgrading and/or adding software, and adding or upgrading peripherals.

To continue an iterative process of evaluation and planned, prescriptive action and to provide continuity for computer system growth and change, it is advisable to establish an on-going planning committee. As the computer system ages, the committee may find it necessary to repeat the entire design process to help ensure orderly and purposeful change to and growth of the computer system through time.

GENERAL OBSERVATIONS

This section discusses some general observations on the research. These observations include the concepts of planning and user involvement as they apply to computer system design in particular and school administration in general, the excitement level in educational computing, and the need for the results of this study.

Planning and User Involvement

Two concepts repeated over and over in both the literature and the field responses and that appear throughout the study's model as key concepts are these:

1. **Planning** is a central element of the computer design process, used at practically every stage from developing a plan-to-plan at the beginning of the process, to the on-going planning that takes place as the computer system adapts and grows over time;

2. **User involvement** should be pervasive through the planning, implementation, and growth of the computer system. Many of the techniques submitted by respondents suggested ways to facilitate user acceptance of the computer system and methods to obtain user inputs to the design process.

These concepts are, of course, very important to educational administration in general. The job of an administrator at any level of management is often that of change agent. However, changes, especially major ones, are often difficult to successfully implement. The concepts of planning and user involvement were found to be essential for effectively changing manual operations into computerized applications. Use of these same concepts can help educational administrators successfully implement other changes in their districts. There are many reasons why changes are unsuccessful and produce negative effects. Lack of planning and user involvement are two of those reasons. Macroscopic and microscopic planning, and inclusion in the process of those who will be affected, are key elements to efficiently and effectively

making any change.

Computing Excitement

There appears to be more field enthusiasm over instructional computing than over administrative data processing. This observation is based upon the unsolicited submission of large amounts of sample documents by instructional respondents. No administrative respondents sent documents with their survey forms; materials were received from them only after verbal requests via telephone interviews.

The reason for this apparent difference in levels of enthusiasm may be related to the purpose of each type of computer system. Administrative computer systems accomplish support tasks; business and management computer applications aid the decision-making that affects instructional matters. However, instructional computer systems are related to the main function of a school, the teaching-learning process. Instructional computing serves the primary clients of a school: the pupils and those who have direct contact with them, the teachers. It may be difficult for the entire district to become enthusiastic about a more efficient method of performing general fund accounting. However, the staff, the students, and the entire community often become excited about ways of improving learning.

Need for the Results of the Study

A genuine need exists for the results of this study. A review of the literature uncovered much related research, but little work directly addressing this topic; no comprehensive computer system model similar to this study's was found. This observation was confirmed by the field research. Practically all of the respondents from the nominator population and the school district populations requested copies of the results of the study.

This may be the norm for participants of any research. However, many respondents from the school district populations wrote to express their concern about a great need for design guidelines that practitioners can use. This was reinforced by conversations with members of the nominator population and the school district populations. Furthermore, the high response rates of the school district populations may be a further indicator of the importance of this topic in the field.

FUTURE IMPLICATIONS

This section speculates on the future direction of electronic technology and implications for the design process.

Assumption 1: The Availability of New Products

Computer technology will continue to advance, and new and better hardware, software, and peripherals will be ever-present in the marketplace.

Implications

The rapid pace of product design may mean that a new computer system is technologically obsolete by the time it is operationalized. This is not to imply that the system will not meet the needs for which it was designed; rather, more sophisticated equipment may be able to increase the efficiency and/or effectiveness of the system. This study found that the majority of changes to computer systems involve upgrades of and/or expansions to the system. With new products appearing in the marketplace at a fast pace -- and the desire of designers to take advantage of these new inventions -- the concepts of evaluation and adaptation may take on increasing importance in the design process.

Assumption 2: Data Storage and Access

Advanced technology will enable more data to be centrally stored in a smaller physical space. Furthermore, increased networking capabilities will enable more users at various work sites, including the home, to access these data.

Implications

The condensation of data storage and the increased ease of data access will bring more emphasis on security and confidentiality. It may be helpful for schools to work with government agencies and private industry for solutions to these problems. Because of the powerful mainframe computers often used in these organizations, they have already been forced to address some of these issues.

Greater networking capabilities may increase the number of users per system. This may put even more emphasis on the concept of user involvement in the design process.

Increased ease of electronic data transfer may reduce the necessity for person-to person contact. A model for computer system design must not ignore the need for human contact and socialization in the work place. There must still exist legitimate reasons for workers to interact, other than breaks and lunch periods. This implication is especially applicable to administrative computer systems. With classroom computing, teachers still interact with students; however, there must still exist opportunities for teachers to work with other teachers.

Assumption 3: Permanency of the Computer Revolution

Micro and mini computers are not fads; they are here to stay. They have found a legitimate place in schools, and their numbers will continue to grow

in districts of all kinds.

Implications

It appears that even districts that have been laggards in computer system adoption now admit that both administrative and instructional computer systems belong in schools. Computers are no longer considered modern frills solely for use in wealthy districts. Therefore, districts of every kind are articulating needs that can be addressed by computer systems. To finance the purchase of these computers, monies must be obtained. In the future, a model for computer system design may place greater emphasis on the aggressive search and procurement of funds.

To encourage the wide-spread use of instructional computer systems by staff, and to increase teachers' efficiency, there may be more emphasis on the use of applications software -- word processing, electronic spreadsheets, and data base management -- for teachers. The results of the survey indicated that this is currently done in some districts; however, there may be an increased emphasis on this aspect of instructional computing in the future.

The preponderance of instructional computer systems will not mean the end of schools as we know them today. Schools and school buildings will always exist because of their custodial and socialization functions; however, the instructional delivery system may change. Computers provide teachers with the capacity to do more individualization of instruction. It may be necessary for teachers to shift their emphasis from group lessons to more accommodation of individual pupil differences. This trend may be reflected in both curriculum development and training techniques. It may be necessary to teach potential users of an instructional computer system not only the operation of the system but also the pedagogy of individualization.

With the increased numbers and uses of computers in schools, job descriptions and hiring criteria may change. For example, one of the selection criteria for administrators, teachers, and office workers may be computing experience. Furthermore, when implementing a new computer system, there may be a few employees who cannot or will not accept or use the computer system. It may be necessary to deal with these individuals in a remedial or even disciplinary manner. These implications may mean an additional role for employee unions. Future versions of the model may reflect not only increased user involvement, but also union participation when the design and operation of a computer system would affect terms and conditions of employment.